Effects of Radius and Direction of Semicircular Tow near the Shoreline on Catch of Postlarval Shrimp (*Penaeus* spp.) with the Renfro Beam Trawl[1]

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ABSTRACT

Two experiments involving sampling of postlarval shrimp (*Penaeus* spp.) with the Renfro beam trawl were conducted near the shoreline at Cheniere la Croix, Marsh Island, Louisiana. Each experiment consisted of six treatment combinations of three radii (50, 100, and 150 ft) and two directions (clockwise and counterclockwise) of a semicircular tow of the trawl with each treatment combination replicated six times. Tows of 50 ft radius provided a measure of relative abundance of postlarvae that was no less efficient than measures provided by tows of greater radius. Because catches in clockwise and counterclockwise tows differed in one experiment, it was suggested that no fewer than duplicate semicircular (in opposite directions) tows be taken to sample postlarvae with the beam trawl.

INTRODUCTION

Renfro (1963) designed and described a 5-ft beam trawl used to sample postlarval shrimp (Penaeidae) in the shallow waters near the shoreline of estuaries. Catches of postlarval shrimp (*Penaeus* spp.) with this gear have been used as measures of relative abundance of this life stage (Baxter and Renfro, 1966) and as indices of subsequent commercial shrimping success (Baxter, 1963).

Renfro (1963) recommended that the net be towed slowly, by a wading operator, in a semicircle of constant radius adjacent to the shoreline. The tow begins and ends at the waterline. In this way, the metal beam of the the net drags and presumably causes postlarvae to rise off the bottom and into the path of the mouth of the net. The beam trawl is therefore an active gear.

Semicircular tows of 150 ft radius have been used by other investigators (Baxter, 1963; Baxter and Renfro, 1966; Christmas, Gunter, and Musgrave, 1966) to sample postlarvae. In our studies of occurrence, abundance, and distribution of postlarval white shrimp (*Penaeus setiferus*) and brown shrimp (*P. aztecus*) in Vermilion Bay, Louisiana, we have employed tows of 100-ft radius, because the bottom is often too soft for wading farther offshore. We have taken duplicate tows (clockwise and counterclockwise) each time a shoreline area was sampled, both to provide a measure of variation in the sampling method and because differences in catch between the two tows might be expected to occur if more water were strained through the net when towed in one direction than when towed in the opposite direction. The latter might occur when currents (caused by tide, wind, or both) deviate from a direction perpendicular to the shoreline at the sampling site.

In hopes of reducing the time and effort required for sampling postlarvae with the beam trawl, we conducted this investigation to determine the effects of radius and direction of semicircular tow with the Renfro beam trawl on catch of postlarval shrimp (*Penaeus* spp.).

STUDY AREA AND SAMPLING METHODS

On 20 July 1965 and again on 1 April 1966, experiments involving sampling of postlarvae with the Renfro beam trawl were conducted near the shoreline at Cheniere la Croix (T 17 S, R 4 E, Section 24), a barrier beach on the south side of Marsh Island, Louisiana. The beach, bordering the Gulf of Mexico, is composed of mud and shell. The tidal flat, at the sampling site, is composed mostly of firm mud.

Both experiments consisted of six treatment combinations of three radii (50, 100, and 150 ft) and two directions (clockwise and coun-

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TABLE 1.—*Arrangement of treatment combinations of three radii (50, 100, and 150 ft) and two directions (clockwise = +, and counterclockwise = −) of semicircular tow with the Renfro beam trawl in 6 × 6 latin square designs*

July 1965						
Sampling periods (rows)[a]	Sequence of tows (columns)					
	First	Second	Third	Fourth	Fifth	Sixth
First	50+	100+	150+	50−	100−	150−
Second	100+	150−	50−	150+	50+	100−
Third	150+	50−	100−	150−	100+	50+
Fourth	50−	50+	150−	100−	150+	100+
Fifth	100−	150+	50+	100+	150−	50−
Sixth	150−	100−	100+	50+	50−	150+
April 1966						
Sampling periods (rows)[b]	Sequence of rows (columns)					
	First	Second	Third	Fourth	Fifth	Sixth
First	100+	100−	150+	150−	50−	50+
Second	150−	50−	100+	100−	50+	150+
Third	150+	50+	100−	50−	100+	150−
Fourth	100−	150+	50+	100+	150−	50−
Fifth	50+	150−	50−	150+	100−	100+
Sixth	50−	100+	150−	50+	150+	100−

[a] Each sampling period began on the hour, the first at 9:00 a.m. and the sixth at 2:00 p.m.
[b] To reduce the duration of the experiment, sampling periods followed one after the other immediately; the first began at 11:00 a.m. and the sixth ended at 3:00 p.m.

TABLE 2.—*Sums[a] of catches (numbers) of postlarval shrimp (*Penaeus *spp.) taken in six replications of semicircular tows of three radii and two directions with the Renfro beam trawl*

July 1965				
Direction	Radius, ft			
	50	100	150	Total
Clockwise	265	143	166	574
Counterclockwise	201	218	259	678
Total	466	361	425	1,252
April 1966				
Direction	Radius, ft			
	50	100	150	Total
Clockwise	3,134	4,787	6,846	14,767
Counterclockwise	2,578	4,031	5,214	11,823
Total	5,712	8,818	12,060	26,590

[a] Individual catches per tow summed over tow sequence (columns) and sampling periods (rows).

terclockwise) of semicircular tow replicated six times in 6 × 6 latin square designs in which six sampling periods represented rows and sequence of tows (first through sixth) within each sampling period represented columns (Table 1). The designs were used to control possible variation in catch that might result from changes in abundance of postlarvae with time, because the major concern was that of the effects of treatment combinations on catch of postlarvae. Samples were fixed in 10–15% formalin, 5% glycerin solution buffered with borax, and postlarvae were later removed from mud and debris and were counted. Subsamples of not more than 25 postlarvae from every sample were identified to species according to Pearson (1939) and Williams (1959).

EFFECTS OF RADIUS AND DIRECTION OF TOW ON CATCH AND CATCH PER UNIT EFFORT

In July 1965, 1,252 postlarvae were captured during the experiment (Table 2). Of the 707 identified to species, 698 were white shrimp and only 9 were brown shrimp. In Louisiana, both white shrimp and brown shrimp postlarvae can be collected in the estuaries during July, but white shrimp domi-

TABLE 3.—*Analysis of variance of $\log_{10}$ (catch of postlarvae per 100 ft of tow), July 1965*

Source of variation	Degrees of freedom	Sum of squares	Mean square	F
Rows (Sampling Periods)	5	2.5276	0.5055	3.580*
Columns (Sequence of Tows)	5	0.9369	0.1874	1.327
Treatment Combinations	5	2.9475	0.5895	4.175*
Radius	(2)	(1.9804)	0.9902	7.013*
Linear	(1)	(1.8296)	1.8296	12.958*
Quadratic	(1)	(0.1508)	0.1508	1.068
Direction	(1)	(0.6146)	0.6146	4.353*
Interaction	(2)	(0.3525)	0.1762	1.248
Linear	(1)	(0.3524)	0.3524	2.496
Quadratic	(1)	(0.0001)	0.0001	0.001
Error	20	2.8236	0.1412	
Total	35	9.2356		

* Indicates significance at $P < 0.05$.

TABLE 4.—*Analysis of variance of $\log_{10}$ (catch of postlarvae per 100 ft of tow), April 1966*

Source of variation	Degrees of freedom	Sum of squares	Mean square	F
Rows (Sampling Periods)	5	0.4690	0.0938	1.744
Columns (Sequence of Tows)	5	0.3954	0.0791	1.470
Treatment Combinations	5	0.3496	0.0699	1.299
Radius	(2)	(0.1603)	0.0802	1.491
Linear	(1)	(0.0967)	0.0967	1.797
Quadratic	(1)	(0.0636)	0.0636	1.182
Direction	(1)	(0.1799)	0.1799	3.344
Interaction	(2)	(0.0094)	0.0047	0.087
Linear	(1)	(0.0003)	0.0003	0.006
Quadratic	(1)	(0.0091)	0.0091	0.169
Error	20	1.0753	0.0538	
Total	35	2.2893		

nate the catches (Broom et al., 1966; Caillouet, 1965; Norden, 1964). In the April 1966, experiment, 26,590 postlarvae were captured. Of the 898 identified, all were brown shrimp. Postlarval white shrimp rarely occur in Louisiana estuaries in April, whereas brown shrimp postlarvae are caught in abundance (Broom et al., 1966; Caillouet, 1965; Norden, 1964).

Prior to calculation of analyses of variance (Tables 3 and 4), a transformation of the data from the two experiments was conducted. Each catch was first divided by the linear distance of tow (i.e., half the circumference of a circle of corresponding radius) and the quotient was multiplied by 100. The resulting value, catch per 100 ft of tow, represented catch per unit effort. These values were then converted to common logarithms to assure additivity of effects and homogeneity of variance. The logarithmic transformation was chosen, because the coefficient of variation (standard deviation/arithmetic mean) of replicated catches of postlarval shrimp with the beam trawl is relatively constant (Caillouet, Fontenot, and Dugas, unpublished).

For July 1965, logarithmically transformed catch per 100 ft of tow exhibited a significant linear decrease with increase in radius of tow (Table 3). Thus, catch per unit effort was greatest in tows of shortest radius or nearer the shoreline. Significant differences were also detected among sampling periods and between directions of tow.

In April 1966, the logarithm of catch per unit effort did not differ significantly among tows of different radii (Table 4). Therefore, catch per unit effort was no greater in tows of 100 and 150 ft radius than in tows of 50 ft radius. There were no significant differences among sampling periods nor between directions of tow, though the latter approached significance.

It was concluded that tows of 50 ft radius provided a measure of relative abundance of postlarvae that was no less efficient than measures provided by tows of greater radius (Figure 1). Reduction in radius of tow would save time and effort in sampling, apparently with no sacrifice of efficiency in capturing postlarvae. Because catches in clockwise and

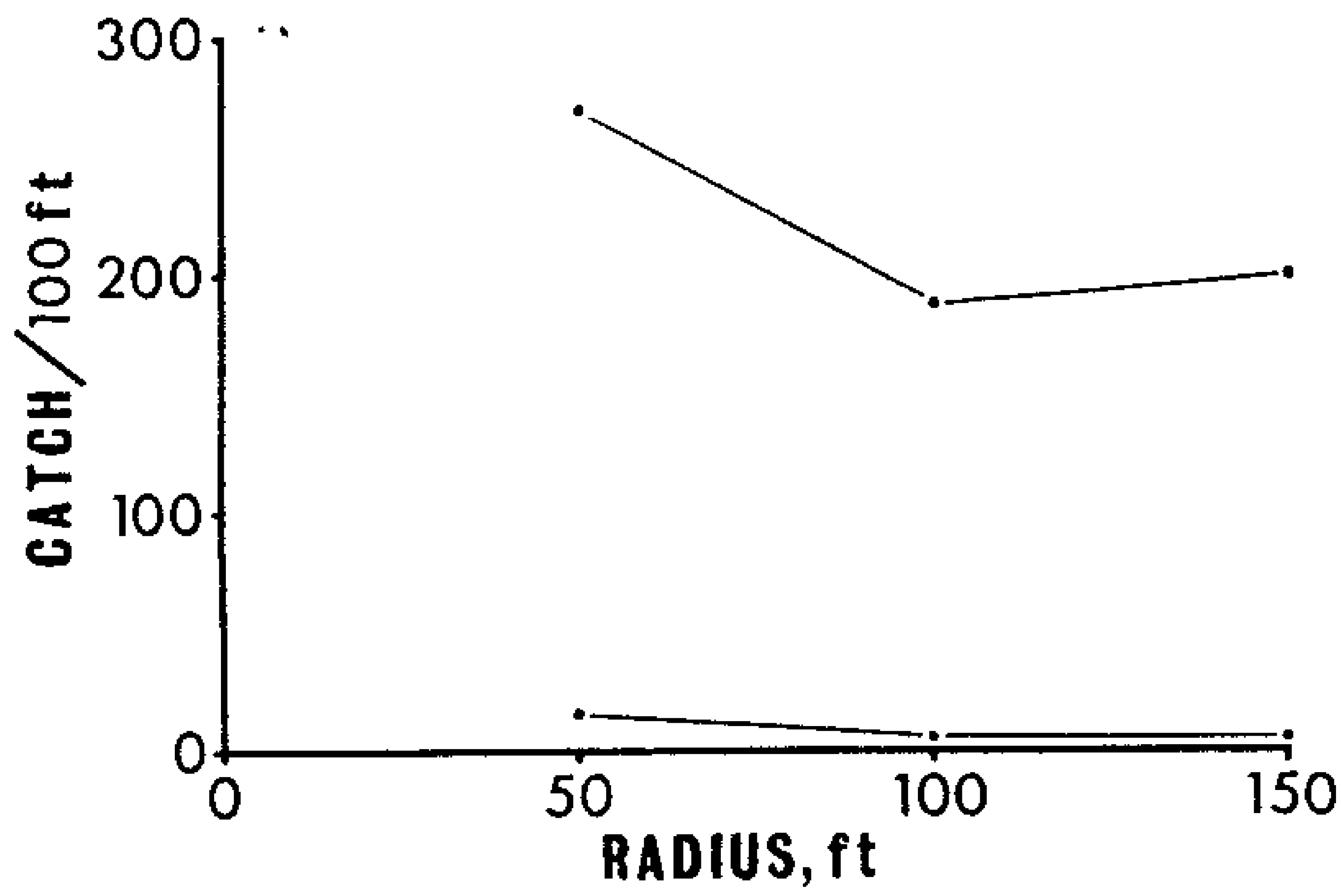

FIGURE 1.—Relationship between geometric mean catch of postlarval shrimp (*Penaeus* spp.) per 100 ft of tow (antilog of mean $\log_{10}$ of catch per 100 ft) and radius of semicircular tow with the Renfro beam trawl (April 1966 above and July 1965 below).

counterclockwise tows may differ in some cases by more than can be attributed to random variation, no fewer than duplicate (clockwise and counterclockwise) tows should be taken to sample postlarvae with the beam trawl.

ACKNOWLEDGMENTS

This study was supported by contracts 14-17-0002-100 and 14-17-0002-131 from the Bureau of Commercial Fisheries, Fish and Wildlife Service, U. S. Department of the Interior. The authors are grateful to Mr. Jack A. Testerman, Associate Professor of Mathematics, University of Southwestern Louisiana, for consultation concerning statistical analyses, and to those who assisted in sampling and identifying postlarvae.

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